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(54) Water heater

(57) A water heater comprises a heating element 1 enclosing a resistive load arranged to be supplied with electrical energy and guide means 4 arranged to ensure that water passing through the heater follows a helical path along the heating element. The guide 4 may be a metal wire covered with an insulating and resilient polymeric material such as polyvinyl chloride. Heating systems may comprise a water circulating pump, a series of heat transfer devices and the electrically operated water heater. The system may use at least two water heaters a first heater which is supplied with electrical energy in accordance with a preset water output temperature and a second, boost, heater which is supplied with electrical energy if the difference between the sensed temperature and the preset temperature exceeds a predetermined limit.

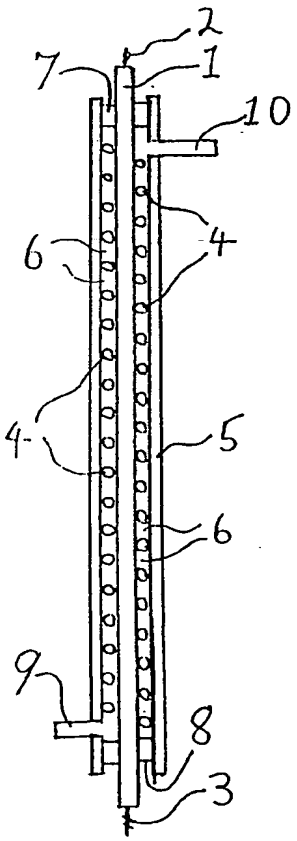

Figure 1

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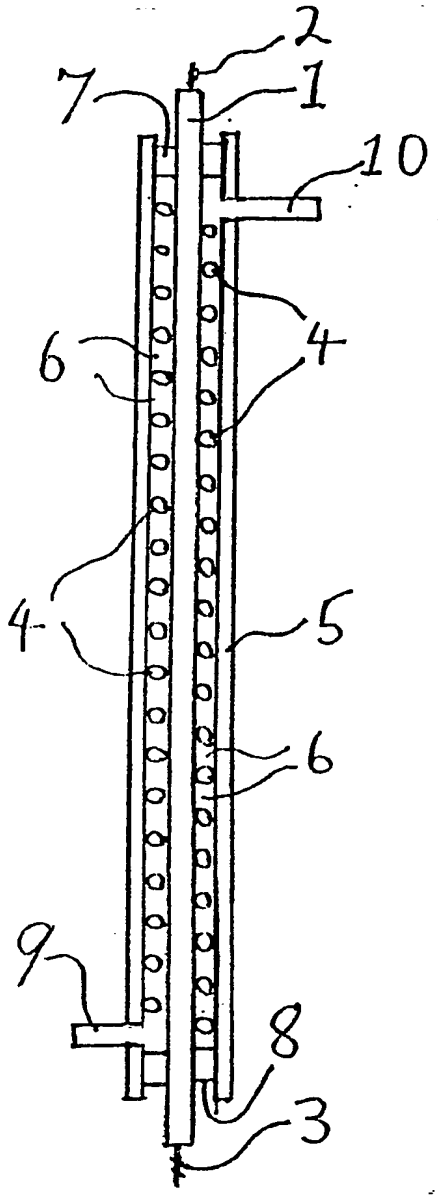

Figure 1

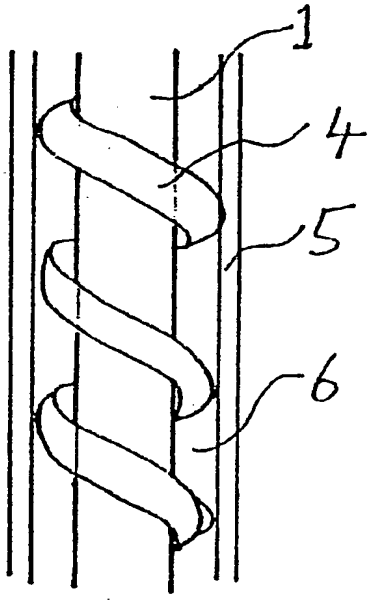

Figure 2

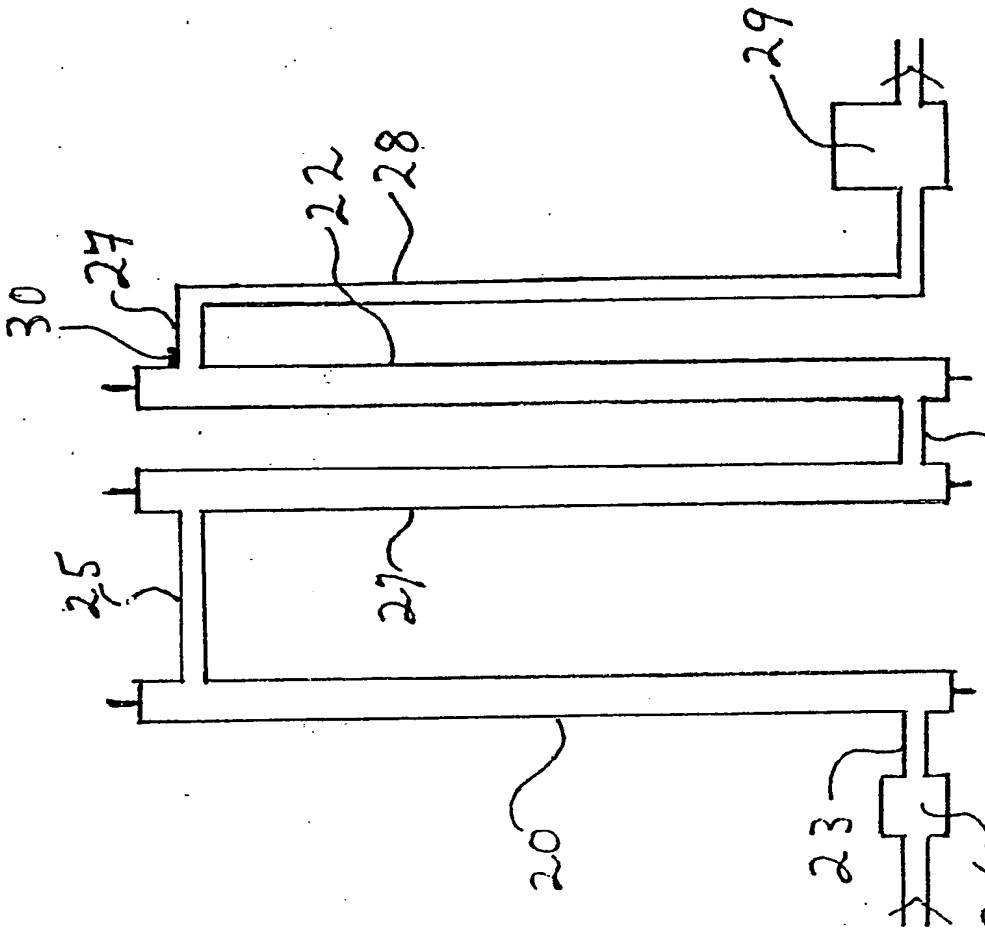

Figure 3

HEATING SYSTEM

This invention relates to heating systems, particularly to compact rapid acting systems for heating rooms and offices.

Heating systems are known in which a heat source raises the temperature of a fluid which is circulated, conventionally by means of a pump, through a series of heat transfer devices and then returned to the heat source. Offices and domestic premises frequently use such systems for so-called central heating. In such central heating systems a large heat source is used, often referred to as a boiler or furnace, which heats water as the circulating fluid. The heat source is necessarily large as it is normally designed to provide sufficient thermal output to the circulating water to meet the maximum demand of the whole of the premises in which it is situated. The energy for heating the water in such systems is frequently produced by the combustion of solid, liquid or gaseous fuel. Apart from the slow reaction time and size of such heat sources they require a fuel supply system, a complicated combustion control system and ducts to supply air for combustion and to remove the products of combustion. The reaction time and thermal efficiency of such heat sources is slow and it takes many minutes for an appreciable change in the temperature of the circulating fluid to take place in response to a demand even with those using gaseous fuel. In some systems the slow response time is to some extent overcome by maintaining a reservoir of heated water associated with the heat source. Heated water is provided immediately the pump is operated from such a reservoir but the size of the heat source is considerably increased.

Heat sources not dependent on combustion are known in which electrical energy is converted to heat by passage through a

resistive load. The conversion of energy is considerably more efficient than by means of combustion but known heat sources of this nature tend to be large and have a slow reaction time.

The present invention provides a compact heating system which has a rapid reaction time.

According to the present invention there is provided a water heater comprising a heating element enclosing a resistive load arranged to be supplied with electrical energy and having water inlet and outlet means, characterised in that it includes guide means arranged to ensure that water passing through the heater from the inlet to the outlet means follows a helical path along the heating element. There is further provided a heating system comprising a water circulating pump, a series of heat transfer devices and an electrically operated water heater, characterised in that the water heater comprises a heating element enclosing a resistive load arranged to be supplied with electrical energy, a water inlet, outlet and guide means arranged to ensure that water passing through the heater follows a helical path along the heating element to enable heat to be transferred rapidly to the circulating water.

The water heater preferably has a low volume, a litre or less. The heating element is preferably fabricated from stainless steel or other corrosion resistant alloy with good thermal conduction. The internal resistive load is formed from one or more strands of high resistivity alloy, such as nickel/chromium alloy, supported and isolated from the sides of the heating element by ceramic beads or a similar heat resistant insulating arrangement. The thermal capacity of the heater is selected to match the

load represented by the water circulation system and associated heat exchangers. The rate of flow and input energy are selected so that water entering at a temperature in the range 10^{o} to $20^{o}C$ leaves at a temperature in the range 40^{o} to $80^{o}C$.

The heating element may be in helical form enclosed in a cyindrical container with guide means adapted to ensure that the water entering and passing through the container follows the surface of the helical heater. Alternatively the heating element may be in linear form, such as a linear tube enclosing a resistive load arranged to be supplied with electrical energy, having a helical guide wound around the linear element. An outer concentric tubular casing encloses the heating element and guide having a diameter which ensures that the guide fills the space between the heater and the casing leaving a helical pathway for the water. Water entering one end of the heater passes along the helical pathway through the heater and thus follows a helical path around the straight heating element ensuring that heat is transferred rapidly to the water as it passes through the heater. In a most preferred form the helical guide is a metal wire covered with an insulating and resilient polymeric material such as polyvinyl chloride. The diameter of the covered wire is equal to or greater than the radial difference bewteen the core and the casing. Such a heater may be easily constructed by winding the wire guide around a linear heater as a core as a series of spaced turns. The spacing between the turns must be sufficient to ensure efficient heat transfer during passage of the water through the helical path but not to present a high resistance to the flow of water. A ratio of 8 - 1 to 14 - 1 turn widths between turns is generally satisfactory with a preferred range of 10 to 12. The outer casing is slid over the straight element carrying the helical guide.

The resilience of the outer covering of the wire ensures a good seal between the element and provides a substantially watertight helical path.

The energy supplied to the heating element may be determined by the ohmic value of the resistive load alone or by electronic energy controlling means such as by a switched thyristor control system.

The circulating pump is controlled in conventional manner by a thermostatic switch located appropriately in the area heated by the system. The water heater is only switched on after circulation has commenced and a steady flow of water is passing through. This may be ensured by means of a flow switch associated with the heater control circuitry. As an additional safeguard a second thermostatic switch disables the water heater if the water leaving it exceeds a preset danger temperature, e.g. $75^{o}C$. The system may include additional control features such as a a clock for determining operating times.

As the circulating water forms a closed system replenishment should not be required unless a leak occurs. The system will require some means, such as a header tank, to allow for expansion and contraction of the water as its temperature varies. The water may contain additives to prevent corrosion of metal pipes, etc and, when used in exposed premises, freezing point depressants such as ethylene glycol.

The heater and pump, together with the associated control components form a compact unit with a low volume and may be housed in a container less than one hundredth of a cubic metre. An electric mains supply is required to supply the necessary thermal energy. Apart from this it is only

necessary to connect the inlet and output pipes of the unit to a water circulation space heating system. Such a system may comprise traditional heat transfer means such as 'radiators' which may be wall mounted or placed along the skirting of the room for even heat distribution.

In a further embodiment a pair of heaters are connected so that the water flows through them successively or in parallel depending on the volume and temperature of heated water that is required. This embodiment allows twice the amount of thermal energy to be supplied to the circulating water than is possible with a single heater. Furthermore, when the heaters are arranged successively, a control system may be used which switches on the second heater as a booster when a system in switched on from cold and thereafter the desired water temperature is sustained by a single heater.

The heater and pump units may be included, with suitable by-pass piping, in existing central heating systems of the type using water circulation. The additional power unit may provide the facility to heat a part of the area involved without the necessity to operate the main system or to boost the thermal energy available so that extensions such as extra rooms can be added to the main system without causing overloading. The units may be installed in association with solar heating systems to provide extra heat at times of low solar energy input due to reduction in day length and overcast skies in combination with cold weather.

In order that the invention may be clearly understood, one form thereof will now be described with reference to the accompanying drawings in which:

Figure 1 shows a cross-sectional view of the electrically

operated water heater used in the heating system according to the invention,

Figure 2 shows schematically the helical guide used to ensure that the water passing through the heater follows a helical path, and

Figure 3 shows a schematic views of a heating system according to the invention.

One embodiment of an electrically operated water heater for use in a heating system according to the invention uses a heating element in linear form, see Figure 1. A linear tube 1 encloses a resistive load, not shown, arranged to be supplied with electrical energy to terminals 2 and 3. A guide wire 4 is wound around the linear tube as a single helix. The guide wire 4 has a metal core and an outer sheath of polyvinyl chloride. An outer concentric cylindrical casing 5 encloses the tube 1 and the helical guide wire 4. The outer diameter of the sheathed wire 4 is chosen to be equal to or greater than the difference between that radii of the outer surface of the tube 1 and the inner surface of the casing 5. Such a diameter ensures that the guide wire 4 fills the space between the tube 1 and the casing 5 providing a helical pathway 6. If the outer diameter is slightly greater than the difference between the radii the sheath is compressed to give an excellent seal. At the ends of the casing 5 and the tube 1 a watertight seal is formed by annular plugs 7 and 8. The helical guide and linear tube are shown in greater detail in Figure 2. One end of the casing 5 has a water inlet pipe 9 and the other a water outlet pipe 10.

In use water enters from the inlet pipe 9 and flows through the helical space 6 until it reaches the outlet pipe 10. Heat is rapidly transferred from the heated tube 1 to the water. Using a 3 kW heater approximately 850 mm length at

a flow rate of 3.9 litres per minute a temperature rise of 11° C is obtained.

One embodiment of a complete a heating system according to the invention, see Figure 3, consists of three electrically operated water heaters 20, 21 and 22. Water heater 20 is connected to the water circulation system by inlet pipe 23 and associated flow detection switch 24. The outlet pipe at the upper end of the water heater 20 is connected to the inlet pipe of water heater 21 through a connecting pipe 25. The water outlet at the lower end of the water heater 21 is connected to the inlet pipe of water heater 22 through a connecting pipe 26. The outlet pipe 27 of water heater 22 is connected through an extension pipe 28 to a water pump 29. A temperature sensor 30 is carried by and in thermal contact with the pipe 27 as close as possible to the exit from the heater 22.

The pump 29 is supplied with power from an electronic control system, not shown, in accordance with the temperature measured by the sensor 30. When water circulation is established, as determined by the flow switch 24, electrical energy is supplied to the water heaters 20, 21 and 22. In a preferred embodiment the heater 20 is a boost heater and energy is only supplied to it if the initially sensed temperature is exceptionally low. Normal operation will only involve energising heaters 21 and 22. Temperature sensitive switches, not shown, are fitted to all the heaters 20, 21 and 22 for safety reasons and ensure that power is removed in the event of the temperature rising to a dangerous value, e.g. 75° C.

For reasons of safety and appearance the heating system is enclosed in a protective casing. In the embodiment shown in Figure 3 a rectangular casing having the dimensions 1000

water heater while a double heater requires the width to be increased to 75 mm. The electronic control system is preferably located separately for ease of use and may contain a clock for setting operating times, signals, etc.

In the illustrated embodiment the water heaters have been shown in a vertical position. In practice the orientation of the heaters does not affect their efficient functioning and they may be operated in a horizontal or other position if more convenient.

In practical installations facilities must be provided in known manner for venting air and other gases released from the water passing through the system. Conventional manually operated or automatic bleed valves can be used. In the case of an installation using vertically oriented heaters as shown in Figure 3 the bleed valves would be fitted to the pipes 25 and 27.

CLAIMS

1. A water heater comprising a heating element enclosing a resistive load arranged to be supplied with electrical energy and having water inlet and outlet means, characterised in that it includes guide means arranged to ensure that water passing through the heater from the inlet to the outlet means follows a helical path along the heating element.

2. The water heater as claimed in claim 1, characterised in that the heating element is a linear tube enclosing a resistive load having a helical guide wound around the linear tube and an outer concentric tubular casing enclosing the tube and guide.

3. The water heater as claimed in claim 2, characterised in that the outer concentric tubular casing has a diameter which ensures that the helical guide fills the space between the linear tube and the casing leaving a helical pathway.

4. The water heater as claimed in either claim 1 or claim 2, characterised in that the helical guide is a metal wire covered with an insulating and resilient polymeric material.

5. The water heater as claimed in claim 4, characterised in that the resilient polymeric material is polyvinyl chloride.

6. The water heater as claimed in either claim 4 or claim 5, characterised in that the diameter of the covered wire is equal to or greater than the radial difference bewteen the outer surface of the linear tube and the inner surface of the casing.

7. A heating system comprising a water circulating pump. a series of heat transfer devices and an electrically operated water heater, characterised in that the water heater comprises a heating element enclosing a resistive load arranged to be supplied with electrical energy, a water inlet, outlet and guide means arranged to ensure that water passing through the heater follows a helical path along the heating element to enable heat to be transferred rapidly to the circulating water.

8. A heating system according to claim 7, characterised in that the heating element supplies thermal energy at the rate of three kilojoules per second to water flowing at a rate in excess of one litre per minute.

9. A heating system according to claim 7 or claim 8, characterised in that a control system prevents operation of the heating element unless water is flowing through it at least one litre per minute.

10. A heating system according to any of the claims 7 to claim 9, characterised in that there are at least two water heaters a first heater which is supplied with electrical energy in accordance with a preset water output temperature and a second, boost, heater which is supplied with electrical energy if the difference between the sensed temperature and the preset temperature exceeds a predetermi ned limit.

11. Water heaters and heating systems as herein described and illustrated with reference to the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

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Relevant Technical fields

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(ii) Int Cl (Edition 5) F24H; H05B; A47J

Search Examiner
A N BENNETT

Databases (see over)
(i) UK Patent Office

(ii)

Date of Search
22 APRIL 1993

Documents considered relevant following a search in respect of claims 1-3,7

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 0620838 (FITZSIMMONS) see Figure 4	1-3,7
X	GB 0172582 (COLEBROOK) whole document	1-3,7
X	EP 0309710 A1 (GAMBRO) see grooves 13	1,7
X	US 4501952 (GRACO), see Figure 4A	1-3,7
X	US 3835294 (BINKS), whole document	1,7

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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